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Description

Circuit arrangement for a multimode mobile telephone for transmitting/receiving signals to/from various mobile radio networks.

The invention relates to a circuit arrangement for a multimode mobile telephone for transmitting/receiving signals to/from various mobile radio networks with a baseband in which at least two analog-digital converters and one digital-analog converter are arranged, and a transceiver unit in which at least a first receiver and a second receiver and at least one transmitter amplifier are arranged, with connections between the outputs of the receivers and the analog-digital converters and a connection between the input of the transmitter amplifier and the digital-analog converter, and also connections between the inputs of the first and second receiver, the output of the transmitter amplifier and an antenna changeover switch, with the antenna changeover switch being connected to a transmitting and receiving antenna, and furthermore means being provided for performing a digital adaptive predistortion.

In many fields, such as with multimode mobile telephones, a linear signal amplification with a high output efficiency is required. One possibility of achieving a linear signal amplification is to fit a non-linear power amplifier (PA), i.e. that has a non-linear curve, before a system, the predistorter. The predistorter distorts the input signals so that the complete system consisting of a predistorter and nonlinear power amplifier again has a substantially more linear behavior than just a power amplifier. This method of application is known as predistortion. The combination of the

predistorter curve of the input signal and the non-linear amplification curve results overall in a linear curve of the transmitting system and thus a linear signal amplification. One problem with this method of application occurs due to the ageing of components or the temperature-dependence of components. These effects in turn change the linearity.

To correct these undesirable effects, with digital adaptive predistortion, the envelope of the amplified signal is regained with the aid of a measuring branch, the feedback branch. An adaptation of the curve of the predistorter is then carried out. This feedback branch consists mainly of a coupler, a demodulator and an analog-digital converter (ADC).

A disadvantage of this method of digital adaptive predistortion is that the feedback branch involves additional costs, installation space and power consumption. For this reason, no linearization methods for power amplifiers requiring a complex feedback branch have so far been realized in commercial systems.

It is therefore the object of the invention to provide a circuit arrangement for a multimode mobile telephone that enables digital adaptive predistortion, without using additional hardware components for the feedback branch.

This object is achieved by the features of the independent Claim 1. Advantageous developments of the invention are the object of subordinate claims.

The inventors have, on one hand, recognized that existing hardware components of a known circuit arrangement for a

multimode mobile telephone are not continually used for their intended tasks, and on the other hand, that these existing hardware components are also suitable for functioning as a feedback branch in the context of digital adaptive predistortion.

Corresponding to the general concept of the invention, the inventors propose an existing circuit arrangement for a multimode mobile telephone for transmitting/receiving signals to/from various mobile radio networks with: a baseband, in which at least two analog-digital converters and one digital-analog converter are arranged, a transceiver unit, in which at least a first receiver and a second receiver and at least one transmitter amplifier are arranged, there being connections both between the outputs of the receivers and the analog-digital converters, and a connection between the input of the transmitter amplifier and the digital-analog converter, and also connections between the inputs of the first receiver, of the second receiver, the output of the transmitter amplifier and an antenna changeover switch, the antenna changeover switch being connected to a transmitting and receiving antenna, and, furthermore, means being provided for performing a digital adaptive predistortion, so that at least one switching element of that kind is arranged in such a way between the output of the transmitter amplifier, of which there is at least one, and the input of the second receiver, that optionally a connection is created that connects the output of the transmitter amplifier, of which there is at least one, with the input of the second receiver and at the same disconnects the connection between the input of this second receiver and the antenna changeover switch.

In this way, it is possible for the second receiver to be disconnected from the transmitting and receiving antenna during the periods when it is receiving no signals from the

transmitting and receiving antenna and therefore to be able to receive other signals. It is therefore possible, by means of a simple switch which in one position of the switch disconnects the second receiver from the transmitting and receiving antenna and at the same time establishes a connection between the output of the transmitter amplifier and the input of the second receiver, for the signals at the output of the transmitter amplifier to be tapped off and detected by the second receiver.

It is particularly favorable if at least one switch element is arranged in the antenna changeover switch. Thus, a separation of the transmitted and received signals with regard to frequency and time takes place in the antenna changeover switch. Certain switching functions are integrated into the antenna changeover switch for these tasks. A particularly advantageous variant for the switching device is proposed by additional integration of the switch element in the antenna changeover switch.

It is particularly advantageous if at least a first receiver receives signals transmitted from the UMTS network and the second receiver, of which there is at least one, receives signals transmitted from the GSM network. Thus, the first receiver can always be available for reception from the UMTS network, while the second receiver, that monitors the GSM network only at times, measures the signal at the transmitter amplifier output in the time in which no signals are received from the GSM network. The second receiver should thus meet the requirements for a UMTS predistortion and also for GSM reception, i.e. this receiver should be reconfigurable. In this way, the existing hardware components, that at certain times are not used, can be more effectively utilized and no additional hardware components, involving extra cost and installation space, need to be fitted in the circuit arrangement.

Additional features and advantages of the invention are given in the following description of preferred exemplary embodiments, with reference to the drawings.

The invention is explained in more detail in the following with the aid of the drawings.

Figure 1: Known circuit arrangement for multimode mobile telephones in which a digital adaptive predistortion is performed with the aid of a feedback branch

Figure 2: Circuit arrangement for multimode mobile telephones in which digital adaptive predistortion is performed with one of two receivers.

Figure 1 shows a known circuit arrangement for multimode mobile telephones, in which digital adaptive predistortion is performed with the aid of a feedback branch 5. This circuit arrangement consists essentially of a transceiver unit 2 and a unit designated as baseband 1, in which the signal predistortion necessary for the digital adaptive predistortion method takes place.

The transceiver unit 2, shown in Figure 1 by a box with a dotted frame, consists of a transmitting and receiving antenna 8 that, by means of an antenna changeover switch 10, has connections 13.1, 13.2 and 14 in each case, to inputs 19.1 and 19.2 of both receivers (RX 1 and RX 2) 3.1 and 3.2, and to output 20 of the transmitter amplifier (TX) 4. In this embodiment, the receiver 3.1 (RX 1) and the transmitter amplifier 4 (TX) are suitable for signal reception from, and signal transmission to, the UMTS network. This is the known FDD-UMTS (Frequency Division Duplex-Universal Mobile Telecommunication System) standard, whereby several frequency bands are used. The

several frequency bands in this case means that simultaneous transmitting and receiving of signals on the various frequency bands is possible, with it being possible to modulate the amplitude and phase of the signals. The GSM (Global System Mobile) network is monitored by receiver 3.2 (RX 2). In the GSM network, the signals are transmitted in time slots, phase-modulated using the time-division multiplex method. Simultaneous transmission and reception of signals is not possible in the GSM network. The frequency and timing of the signals transmitted and received via the transmitting and receiving antenna 8 can be separated by means of the antenna changeover switch 10.

The baseband 1 is shown within the dotted box on the left in Figure 1. The baseband 1 has a total of three analog-digital converters 6.1 to 6.3 and a digital-analog converter 7. Both top analog-digital converters 6.1 and 6.2 each receive analog signals via connections 11.1 and 11.2 transmitted from the outputs 17.1 and 17.2 of the first and second receivers (RX 1 and RX 2) 3.1 and 3.2. In order to be able to perform digital adaptive predistortion with this circuit arrangement, the lowest digital-analog converter 7 is provided in baseband 1 that transmits the predistorted signals via connection 12 to the input 18 of the transmitter amplifier 4 (TX).

To obtain linear signal amplification with this circuit arrangement, the signal fed in via connection 12 to input 18 of the transmitter amplifier (TX) 4 and predistorted must be tapped off at output 20 of the transmitter amplifier (TX) 4 and compared with the fed-in signal.

To this, a branch 15, as a measuring branch, is provided at the output 20 of the transmitter amplifier (TX) 4. This measuring

branch, also known as a feedback branch 5, also uses the lowest analog-digital converter 6.3. By comparing the signal fed in at input 18 with the signal output at output 20, non-linearities of the signal amplification can be detected and corrected.

Figure 2 shows a new circuit arrangement for multimode mobile telephones in which a digital adaptive predistortion can be performed with one receiver (RX 2) 3.2 of two receivers (RX 1 and RX 2) 3.1 and 3.2. Similar to Figure 1, this circuit arrangement consists essentially of a transceiver unit 2 and a unit designated as baseband 1.

Similar to Figure 1, the transceiver unit 2 consists of a transmitting and receiving antenna 8 that, via antenna changeover switch 10, has connections 13.1, 13.2 and 14 to both inputs 19.1 and 19.2 of the receivers (RX 1 and RX 2) 3.1 and 3.2 respectively and to the output 20 of the transmitter amplifier (TX) 4. In this embodiment, the receiver 3.1 (RX 1) and the transmitter amplifier 4 (TX) are suitable for signal reception and signal transmission to the UMTS network. This is the known FDD-UMTS (Frequency Division Duplex-Universal Mobile Telecommunication System) standard, whereby several frequency bands are used. By means of the several frequency bands, simultaneous transmission and reception of signals on the different frequency bands is possible in this case, with modulation of the amplitude and phase of the signals being possible. The GSM (Global System Mobile) network is monitored by the second receiver 3.2 (RX 2). In the GSM network, the signals are transmitted in time slots, phase-modulated using the time-division multiplex method. Simultaneous transmission and reception of signals is not possible in the GSM network. By means of the antenna changeover switch 10, the signals received and transmitted via the transmitting and

receiving antenna 8 are separated with respect to frequency and time.

In contrast to Figure 1, no separate feedback branch 5 is provided in the new circuit arrangement at the output of the transmitter amplifier (TX) 4 for monitoring the signal at the output 20 of the transmitter amplifier (TX) 4. The absence of the feedback branch 5 can mean that the analog-digital converter 6.3 (lowest ADC from Figure 1) in the baseband 1 that was previously necessary can now be omitted.

In order, nevertheless, to be able to detect the signal at output 20 of the transmitter amplifier (TX) 4 with the new circuit arrangement, a switch 9 is fitted. When the switch 9 is in switch setting II, the input 19.2 of the receiver (RX 2) 3.2 is connected, via the optional connection 13.2', to the antenna changeover switch 10 and the transmitting and receiving antenna 8. The GSM network can thus be monitored in switch setting II. As described above, in the GSM network the signals are transmitted in time slots, phase-modulated using the time-division multiplex method.

That means that it is now possible in these time slots in which no GSM signals are transmitted to input 19.2 of the receiver (RX 2) 3.2, to use this receiver (RX 2) 3.2 to monitor the signals that are output at output 20 of the transmitter amplifier (TX) 4. To do this, the switch 9 is moved to switch setting I in these time slots and thus the optional connection 13.2' between the second receiver (RX 2) 3.2 and the antenna changeover switch 10 is disconnected and at the same time the optional connection 16' from the output 20 of the transmitter receiver (TX) 4 to the input 19.2 of the second receiver (RX 2) 3.2 is established. The second receiver (RX 2) 3.2 and the

analog-digital converter 6.2 now function as a feedback branch.

Overall therefore, the invention presents a circuit arrangement for a multimode mobile telephone that enables digital adaptive predistortion to be carried out. In contrast to previously, with this circuit arrangement an additional measuring branch is not necessary to measure the amplified signal, but instead the existing hardware components of the circuit arrangement are switched in such a way that they have the same function as the measuring branch. Depending on the switch setting of the switching element, the second receiver is suitable for, for example, performing a UMTS predistortion and also suitable for GSM reception.

It is obvious that these named features of the invention can be used not only in the particular combination given but also in other combinations or alone, without departing from the framework of the invention.

List of reference characters

1	Baseband
2	Transceiver unit
3.1	First receiver RX 1
3.2	Second receiver RX 2
4	Transmitter amplifier TX
5	Feedback branch
6.1	Analog-digital converter (ADC) of the first receiver RX 1
6.2	Analog-digital converter (ADC) of the second receiver RX 2
6.3	Analog-digital converters (ADC) of the feedback branch
7	Digital-analog converter (DAC) of the transmitter amplifier TX
8	Transmitting and receiving antenna
9	Switch with two switch settings I and II
10	Antenna changeover switch/Front End (FE)
11.1	Connection of the output of the first receiver RX 1 to the analog-digital converter 6.1
11.2	Connection of the output of the second receiver RX 2 to the analog-digital converter 6.2
11.3	Connection of the feedback branch to the analog-digital converter 6.3
12	Connection of the digital-analog converter with the input of the transmitter amplifier TX
13.1	Connection of the antenna changeover switch to the input of the first receiver RX 1
13.2	Connection of the antenna changeover switch to the input of the second receiver RX 2

13.2′	Optional connection of the antenna changeover switch to the input of the second receiver RX 2
14	Connection of the output of the transmitter amplifier TX to the antenna changeover switch
15	Branch of the output of the transmitter amplifier TX to the feedback branch
16′	Optional connection of the output of the transmitter receiver TX to the input of the second receiver RX 2
17.1	Output of the first receiver RX 1
17.2	Output of the second receiver RX 2
18	Input of the transmitter amplifier TX
19.1	Input of the first receiver RX 1
19.2	Input of the second receiver RX 2
20	Output of the transmitter amplifier TX